



## Rehabilitation of Stroke Patients

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**Abstract:** The article provides an overview of available and the most effective methods of rehabilitation of stroke patients. The principles of rehabilitation measures at the main clinical manifestations of stroke, causing persistent disability of the patient are considered. The efficiency of new experimental methods of rehabilitation is discussed.

**Key words:** stroke, rehabilitation, efficiency.

Stroke is an acute cerebrovascular accident one of the main causes of disability and mortality of the population. In addition to the unconditional medical and social significance, a stroke also brings a colossal economic damage. For example, in the United States, the costs associated with the treatment and rehabilitation of patients with stroke, as well as economic losses associated with disability, are 6.5-11.2 billion dollars a year. The problem of stroke is especially relevant in the Russian Federation, where 450 thousand cases of stroke are recorded annually and for every 100 thousand population accounts for 600 patients with consequences stroke, of which 60% remain disabled [2, 9].

In recent decades, significant advances have been made in the diagnosis, treatment and prevention of ischemic stroke, which have significantly reduced mortality and improve functional prognosis. Concept pathogenetic heterogeneity of ischemic stroke has become the basis of a differentiated approach to treatment and primary/secondary prevention. Treatment of patients with ischemic stroke includes the following aspects: general measures, reperfusion therapy, secondary prevention and rehabilitation, symptomatic therapy, relief complications [4, 8].

All patients with ischemic stroke or transient ischemic attack, secondary prevention of repeated cerebrovascular accidents is indicated [16]. Specific list of preventive measures depends on the subtype of stroke. In all cases it is necessary correction of risk factors, primarily normalization BP, compensation for diabetes mellitus, lifestyle changes (cessation of smoking, alcohol abuse, adequate diet, etc.) [10]. currently transferred ischemic stroke is considered as a direct indication to the start of statin therapy [11]. The basis of secondary prevention is currently made up of antiplatelet agents, in particular acetylsalicylic acid [5].

Dipyridamole or clopidogrel prescribed for intolerance to acetylsalicylic acid, and also if a stroke developed while taking it. In the case of cardioembolic stroke, the use of indirect anticoagulants (warfarin) is acceptable [7, 14, 15, 19].

The main principles of the rehabilitation of stroke patients include the early start of rehabilitation measures with the activation of the patient, a multidisciplinary organized approach, continuity, consistency and continuity at all stages of its implementation. In most cases (more than 80%), movement disorders (hemiparesis, monoparesis) determine the degree of disability, disability and disruption of household activity [17]. Rehabilitation of patients after a stroke is not limited to measures to restore only motor functions. Other disorders that necessitate rehabilitation include disorders speech (various aphasias) and other higher cortical functions, sensory disturbances, dysphagia, visual disturbances and others [22].

Neurophysiological mechanisms that allow recovery of motor functions in patients with stroke are complex and diverse. In the early period (first days and weeks after a stroke) the main value is restoration of functional activity morphologically intact, but temporarily disorganized neurons located perifocal in relation to the lesion. This is possible due to such phenomena, developing in the first weeks after a stroke, as the resolution of edema, the development of the collateral circulation system and the restoration of perfusion of the affected area of the brain. Further the neurophysiological basis of recovery are processes of brain plasticity associated with the reorganization of normal physiological relationships between the various brain structures involved in carrying out this function. The leading importance is collateral sprouting (growth of damaged fibers with the formation of new synapses), denervation hypersensitivity (receptors become more sensitive to neurotransmitters or increase in quantity), unmasking, in which resting neuronal connections are inhibited, but are activated after damage [21, 22].

**Kinesiotherapy** is a form of therapeutic gymnastics, including positional treatment, passive and active movements. Taking into account the fact that the processes of restoring functional activity of intact neurons and functional reorganization are most active in the early stages after a stroke, rehabilitation should begin as early as possible on the first day, and kinesiotherapy is given the most important value [1, 3]. The main purpose of these activities is to prevent the development of contractures and bedsores. In the future, kinesiotherapy is intended to solve two main groups of tasks - a general tonic effect on the body, training of the cardiovascular system, activation of cerebral hemodynamics; and effects on movement disorders (in the recovery period of the disease – assistance restoration of motor functions, in the residual development of subcompensations, development of contractures). The methods of physical therapy used for this purpose are conditionally subdivided into standard and neurophysiological [2,3].

The standard exercise therapy includes various combinations of exercises to increase range of motion and resistance exercises, mobilization activity, compensatory techniques, functionally oriented (i.e. training movements of daily activity). Neurophysiological techniques include methods where the exercise program is based on neuromuscular "retraining" programs.

According to the results of numerous studies, it has been proven that early mobilization and verticalization of the patient after a stroke due to the widespread use of the standard and neurophysiological therapeutic gymnastics leads to a significantly better functional recovery. Besides these activities contribute to the prevention of development congestive pneumonia, bedsores and thrombophlebitis of the lower limbs [5].

In recent years, new methods of post-stroke rehabilitation have been studied and efforts have been made to find more effective exercises. One of the methods for this forced movement therapy technique is in intensive training for 2 weeks of a paretic limb with functionally oriented exercises, with this non-paretic upper limb is tied, in order to work a weak upper limb. Forced movement therapy is based on significant findings from small studies of post-stroke rehabilitation suggesting that improved function can be achieved even in people with chronic, persistent motor deficits [58]. Feature change shown cortex on functional magnetic resonance imaging and transcranial magnetic stimulation

associated with forced movement therapy [7, 6]. One study examined the use of this technique in patients in early period after a stroke and has been proven to be safe, good tolerability and positive effect of this method [7]. The theoretical basis of these approaches remains unclear. The effect of this therapy is thought to be related to the prevention of non-use of the affected limb and mobilization of preserved but inactive cortical motor centers [6].

**Physiotherapy.** Of the methods of physiotherapy traditionally used in the rehabilitation of patients after a stroke, it follows mention measures to reduce spasticity, which makes a significant contribution to the disability of patients. In addition to treatment with a position to prevent development of early contractures and normalize the stretch reflex, and daily passive and passive-active exercises at a slow pace, sometimes with the help of special devices that also prevent the development of contractures, reduce the hyperactivity of stretch reflexes and improve motor control, apply cryotherapy, hydrotherapy, electrical muscle stimulation [18, 12].

**Computerized and robotic systems of kinesiotherapy.** In recent years, many methods of kinesiotherapy have appeared using various computerized and robotic systems. Successes in robotics allowed the development of robotic systems that can reliably and safely assist during exercise. Robots operate under the control of special programs to provide assistance when performing movements, resistance to unwanted movements or even resisting planned movements to ensure accuracy exercises.

This category of patients improved motor function when performing exercises on a semi-automatic robot in the early recovery period after stroke and in individuals with persistent chronic motor deficit [29, 30]. The results obtained are stored for a long time [60]. It is also obvious that there is a qualitative improvement in movement during the rehabilitation of robotic upper limb, which after exercise become smoother and more coordinated [51].

Probably one of the mechanisms of action of this technique are plastic changes in the motor cortex. Semi-automated robotic treatment may in the future be combined with forced movement therapy. In the end As a result, this contributes to an increase in the number of effective therapeutic exercises.

**Virtual reality training** is aimed at creating a favorable environment for learning motor skills. Complex for creating a virtual reality besides the computer includes numerous motion and position sensors, glasses with liquid crystal the monitor to which the image is directly transmitted. Exercises are carried out in specially designated rooms. Most often, with the help of virtual reality, rooms with everyday furnishings and corridors are modeled, along which it is necessary to move. Application efficiency developed systems to create a virtual in the process rehabilitation of post-stroke patients and after craniocerebral injuries is indicated in small pilot studies [3, 8], but they have not been tested in well-controlled clinical trials. To date, virtual reality systems are mainly based on visual effects, although future systems will allow more and tactile sensations. Some researchers prefer to use non-immersive (non-directional) training in virtual reality due to easier tolerability and low risk of side effects such as dizziness and nausea. For this reason training in a virtual environment should be aimed at compensating certain motor skills, since in studies on healthy people demonstrated with the development of side effects, the loss of the effectiveness of complex exercises in virtual reality [45].

For training walking on a treadmill use special belts to partially reduce weight the patient's body. In studies on cats with damaged spinal cord demonstrated effective facilitation of gait pattern generation through training on treadmill. There is a hypothesis that similar training in patients after a stroke, they can stimulate the generation of an impaired walking pattern. And in some studies on people showed improvement in walking [5].

Other studies have found that the use of aggressive training walking using a more conventional technique (i.e. intensive physical therapy paired with early strengthening of the lower limbs) can be equally effective [4].

The effectiveness of a treadmill workout depends on the speed of movement of the track itself: in one study, better recovery results were observed walking [5, 7]. But the training method is very labor intensive, which is a serious limiting factor for its application in routine practice. Development of robotic systems and training aids for the lower extremities make this type of training more feasible in the future [4, 6].

**Medical correction of spasticity.** Muscle relaxants (tolperisone, tizanidine, baclofen) - widely used a group of drugs that can inhibit polysynaptic spinal reflexes with less influence on monosynaptic ones. They are successfully used in the rehabilitation of patients with spastic paralysis, including after a stroke. From side effects include arterial hypotension, in some cases limiting their use. Besides in some patients, their muscle relaxant effect is insufficient or short-lived, in connection with this, in recent years are increasingly being used with encouraging results local intramuscular injections of botulinum toxin type A. The therapeutic activity of the drug is due to its ability to cause reversible chemical muscle denervation [1].

**Experimental approaches to the rehabilitation of patients after a stroke.** The underlying pathomorphological substrate in stroke is cerebral necrosis. tissue that consists of neurons, their processes and neuroglia. The basic principle of stroke therapy should be directed to recovery of necrotic tissue. Although the achievement this goal is a matter of the future, already at the present stage of development medicine, partial restoration of damaged connections between neurons and lost neurons. New Advances in Applying Growth Factors to Stimulus reparative processes and neuronal stem cells to replenish lost neurons - actively and quickly an emerging area of basic medical research. In the coming years, the earlier clinical use of these methods will become increasingly important as a component of rehabilitation.

Growth factors can stimulate dendritic and axonal outgrowth and increase the interconnection of existing neurons, they also stimulate the proliferation of neuronal stem cells, which in principle are capable of replace some of the lost cells. In research recovery processes after a stroke discovered signs of axon sprouting and the formation of new synapses. Sprouting of axons depends on the activity of the patient during the early post-stroke recovery period and immobility can interfere with this process [4].

Stem cells are pluripotent (capable of to differentiation in various directions) precursor cells that retain the ability to regenerate, as well as differentiate into many mature types cells. Recently, in the mammalian brain, neuronal stem cells [31]. Promising the results of studies of the effectiveness of stem cell transplantation after an experimental stroke were found in animals.

One of these studies demonstrated a reduction in motor deficits [9]. Fully all factors that modulate the proliferation and differentiation of endogenous stem cells are known [37]. Strategy stem cell applications include the use of growth factors to stimulate proliferation, cell injection, secreting local trophic factors and transplantation exogenous stem cells. Until now, this approach remains experimental and requires further research.

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